

1. A method of temporarily reducing the permeability of one or more selected sections of a subterranean formation penetrated by a horizontal well bore and the flow of water or water and hydrocarbons or hydrocarbons therefrom comprising the steps of:

(a) preparing or providing an aqueous treating fluid comprising water and a water-soluble formation permeability reducing agent selected from the group consisting of a hydrophobically modified water-soluble polymer, a hydrophilically modified water-soluble polymer and a hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone; and

(b) introducing the aqueous treating fluid containing the water-soluble formation permeability reducing agent into the one or more selected sections so that the permeabilities and flows of water or water and hydrocarbons or hydrocarbons therefrom are reduced.

2. The method of claim 1 wherein the water-soluble formation permeability reducing agent is a hydrophobically modified water-soluble polymer present in the aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the aqueous treating fluid.

3. The method of claim 2 wherein the hydrophobically modified water-soluble polymer is the reaction product of a hydrophilic reactive polymer and a hydrophobic compound.

4. The method of claim 3 wherein the hydrophilic reactive polymer comprises a reactive amino group.

5. The method of claim 3 wherein the hydrophilic reactive polymer is a product of a polymerization reaction in which at least one monomer is selected from the group consisting of dimethylaminoethyl methacrylate and dimethylaminopropyl methacrylamide.

6. The method of claim 3 wherein the hydrophilic reactive polymer is selected from the group consisting of polyethyleneimine, polyvinylamine, poly(vinylamine/vinyl alcohol), chitosan and polylysine.

7. The method of claim 3 wherein the hydrophilic reactive polymer comprises an alkyl acrylate polymer.

8. The method of claim 7 wherein the alkyl acrylate polymer is selected from the group consisting of polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide) and poly(acrylic acid/dimethylaminoethyl methacrylate).

9. The method of claim 3 wherein the hydrophobic compound comprises an alkyl halide.

10. The method of claim 9 wherein the alkyl halide comprises an alkyl chain of from about 4 to about 30 carbon atoms.

11. The method of claim 3 wherein the hydrophobic compound comprises cetyl bromide.

12. The method of claim 2 wherein the hydrophobically modified water-soluble polymer is a reaction product of a hydrophilic monomer and a hydrophobically modified hydrophilic monomer.

13. The method of claim 12 wherein the hydrophilic monomer is selected from the group consisting of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, dimethylaminoethyl methacrylate, acrylic acid, dimethylaminopropyl methacrylamide, vinyl amine, trimethylammoniummethyl methacrylate chloride, methacrylamide and hydroxyethyl acrylate.

14. The method of claim 12 wherein the hydrophobically modified hydrophilic monomer is selected from the group consisting of alkyl acrylates, alkyl methacrylates, alkyl acrylamides and alkyl methacrylamides wherein the alkyl radicals have from about 4 to about 30 carbon atoms; alkyl dimethylammoniummethyl methacrylate bromide, alkyl dimethylammoniummethyl methacrylate chloride and alkyl dimethylammoniummethyl methacrylate iodide wherein the alkyl radicals have from about 4 to about 30 carbon atoms; and alkyl dimethylammoniumpropyl methacrylamide bromide, alkyl dimethylammoniumpropyl methacrylamide chloride and alkyl dimethylammoniumpropyl methacrylamide iodide wherein the alkyl groups have from about 4 to about 30 carbon atoms.

15. The method of claim 12 wherein the hydrophobically modified hydrophilic monomer is selected from the group consisting of octadecyldimethylammoniummethyl methacrylate bromide, hexadecyldimethylammoniummethyl methacrylate bromide, hexadecyldimethylammoniumpropyl methacrylamide bromide, 2-ethylhexyl methacrylate and hexadecyl methacrylamide.

16. The method of claim 2 wherein the hydrophobically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.

17. The method of claim 12 wherein the hydrophilic monomer and the hydrophobically modified hydrophilic monomer are present in the hydrophobically modified water-soluble polymer at a mole ratio of from about 99.98:0.02 to about 90:10.

18. The method of claim 12 wherein the hydrophobically modified water-soluble polymer is selected from the group consisting of acrylamide/octadecyldimethylammoniummethyl methacrylate bromide copolymer, dimethylaminoethyl methacrylate/hexadecyldimethylammoniummethyl methacrylate bromide copolymer, dimethylaminoethyl methacrylate/vinyl pyrrolidone/hexadecyldimethylammoniummethyl methacrylate bromide terpolymer and acrylamide/2-acrylamido-2-methyl propane sulfonic acid/2-ethylhexyl methacrylate terpolymer.

19. The method of claim 18 wherein the hydrophobically modified water-soluble polymer comprises a dimethylaminoethyl methacrylate/hexadecyldimethylammoniummethyl methacrylate bromide copolymer having a mole ratio of hydrophilic monomer to hydrophobically modified hydrophilic monomer of 95:5.

20. The method of claim 1 wherein the water-soluble formation permeability reducing agent is a hydrophilically modified water-soluble polymer present in the aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the first aqueous treating fluid

21. The method of claim 20 wherein the hydrophilically modified water-soluble polymer is a reaction product of a hydrophilic reactive polymer and a hydrophilic compound.

22. The method of claim 21 wherein the hydrophilic reactive polymer comprises a reactive amino group.

23. The method of claim 21 wherein the hydrophilic reactive polymer is a product of a polymerization reaction in which at least one monomer is selected from the group consisting of dimethylaminoethyl methacrylate and dimethylaminopropyl methacrylamide.

24. The method of claim 21 wherein the hydrophilic reactive polymer is selected from the group consisting of polyethyleneimine, polyvinylamine, poly(vinylamine/vinyl alcohol), chitosan and polylysine.

25. The method of claim 21 wherein the hydrophilic reactive polymer comprises an alkyl acrylate polymer.

26. The method of claim 25 wherein the alkyl acrylate polymer is selected from the group consisting of polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide) and poly(acrylic acid/dimethylaminoethyl methacrylate).

27. The method of claim 21 wherein the hydrophilic reactive polymer is a reaction product of a hydrophilic monomer copolymerized with monomers containing reactive amino groups.

28. The method of claim 27 wherein the hydrophilic monomer is selected from the group consisting of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, acrylic acid, trimethylammoniumethyl methacrylate chloride, methacrylamide and hydroxyethyl acrylate.

29. The method of claim 21 wherein the hydrophilic compound is selected from the group consisting of halogen containing polyethers.

30. The method of claim 29 wherein the polyether is selected from the group consisting of polyethylene glycol, polypropylene glycol, polybutylene glycol, and mixtures thereof.

31. The method of claim 29 wherein the halogen containing polyether comprises an epichlorohydrin terminated polyethylene glycol methyl ether.

32. The method of claim 20 wherein the hydrophilically modified water-soluble polymer comprises a polymer having a molecular weight in the range of from about 100,000 to about 10,000,000.

33. The method of claim 29 wherein the weight ratio of the hydrophilic reactive polymer to the halogen containing polyether is in the range of from about 1:1 to about 10:1.

34. The method of claim 21 wherein the hydrophilically modified water-soluble polymer is selected from the group consisting of the reaction product of polydimethylaminoethyl methacrylate with epichlorohydrin terminated polyethylene glycol methyl ether, the reaction product of poly(acrylamide/dimethylaminoethyl methacrylate) with epichlorohydrin terminated polyethylene glycol methyl ether, the reaction product of polydimethylaminopropyl

methacrylamide with epichlorohydrin terminated polyethylene glycol methyl ether, and the reaction product of poly(acrylamide/dimethylaminopropyl methacrylamide) with epichlorohydrin terminated polyethylene glycol methyl ether.

35. The method of claim 20 wherein the hydrophilically modified water-soluble polymer comprises a polydimethylaminoethyl methacrylate epichlorohydrin terminated polyethylene glycol methyl ether reaction product having a mole ratio of polydimethylaminoethyl methacrylate to epichlorohydrin terminated polyethylene glycol methyl ether of 3:1.

36. The method of claim 1 wherein the water-soluble formation permeability reducing agent is a hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone present in the aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the aqueous treating fluid.

37. The method of claim 36 wherein the hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone is the reaction product of a hydrophilic polymer comprising polar heteroatoms within the polymer backbone and a hydrophobic compound.

38. The method of claim 36 wherein the polar heteroatoms present in the polymer backbone of the hydrophobically modified water-soluble polymer are selected from the group consisting of oxygen, nitrogen, sulfur and phosphorous.

39. The method of claim 37 wherein the hydrophilic polymer comprising polar heteroatoms within the polymer backbone is selected from the group consisting of a cellulose, a

chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone and a starch.

40. The method of claim 39 wherein the starch comprises a cationic starch.

41. The method of claim 37 wherein the hydrophobic compound is selected from the group consisting of an alkyl halide, a sulfonate, a sulfate, and an organic acid derivative.

42. The method of claim 41 wherein the organic acid derivative is selected from the group consisting of an octenyl succinic acid, a dodecenyl succinic acid, and an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.

43. The method of claim 37 wherein the hydrophobic compound has an alkyl chain length of from about 4 to about 30 carbons.

44. The method of claim 1 wherein the aqueous treating fluid further comprises a gelling agent.

45. The method of claim 36 wherein the hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone has a molecular weight in the range of from about 100,000 to about 10,000,000.

46. A method of temporarily reducing the permeability of one or more selected sections of a subterranean formation penetrated by a horizontal well bore and the flow of water or water and hydrocarbons or hydrocarbons therefrom and restoring the permeability and flow when required comprising the steps of:



(a) preparing or providing an aqueous treating fluid comprising water and a water-soluble formation permeability reducing agent selected from the group consisting of a hydrophobically modified water-soluble polymer, a hydrophilically modified water-soluble polymer and a hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone;

(b) introducing the first aqueous treating fluid containing the water-soluble formation permeability reducing agent into the one or more selected sections so that the permeabilities and flows of water or water and hydrocarbons or hydrocarbons therefrom are reduced; and

(c) when required, contacting said one or more selected sections with a second aqueous treating fluid comprising water and a formation permeability restoring chemical.

47. The method of claim 46 wherein the water-soluble formation permeability reducing agent is a hydrophobically modified water-soluble polymer present in the first aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the first aqueous treating fluid.

48. The method of claim 47 wherein the hydrophobically modified water-soluble polymer is the reaction product of a hydrophilic reactive polymer and a hydrophobic compound.

49. The method of claim 48 wherein the hydrophilic reactive polymer comprises a reactive amino group.

50. The method of claim 48 wherein the hydrophilic reactive polymer is a product of a polymerization reaction in which at least one monomer is selected from the group consisting of dimethylaminoethyl methacrylate and dimethylaminopropyl methacrylamide.

51. The method of claim 48 wherein the hydrophilic reactive polymer is selected from the group consisting of polyethyleneimine, polyvinylamine, poly(vinylamine/vinyl alcohol), chitosan and polylysine.

52. The method of claim 48 wherein the hydrophilic reactive polymer comprises an alkyl acrylate polymer.

53. The method of claim 52 wherein the alkyl acrylate polymer is selected from the group consisting of polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide) and poly(acrylic acid/dimethylaminoethyl methacrylate).

54. The method of claim 48 wherein the hydrophobic compound comprises an alkyl halide.

55. The method of claim 54 wherein the alkyl halide comprises an alkyl chain of from about 4 to about 30 carbon atoms.

56. The method of claim 48 wherein the hydrophobic compound comprises cetyl bromide.

57. The method of claim 47 wherein the hydrophobically modified water-soluble polymer is a reaction product of a hydrophilic monomer and a hydrophobically modified hydrophilic monomer.

58. The method of claim 57 wherein the hydrophilic monomer is selected from the group consisting of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, dimethylaminoethyl methacrylate, acrylic acid, dimethylaminopropyl methacrylamide, vinyl amine, trimethylammoniummethyl methacrylate chloride, methacrylamide and hydroxyethyl acrylate.

59. The method of claim 57 wherein the hydrophobically modified hydrophilic monomer is selected from the group consisting of alkyl acrylates, alkyl methacrylates, alkyl acrylamides and alkyl methacrylamides wherein the alkyl radicals have from about 4 to about 30 carbon atoms; alkyl dimethylammoniummethyl methacrylate bromide, alkyl dimethylammoniummethyl methacrylate chloride and alkyl dimethylammoniummethyl methacrylate iodide wherein the alkyl radicals have from about 4 to about 30 carbon atoms; and alkyl dimethylammoniumpropyl methacrylamide bromide, alkyl dimethylammoniumpropyl methacrylamide chloride and alkyl dimethylammoniumpropyl methacrylamide iodide wherein the alkyl groups have from about 4 to about 30 carbon atoms.

60. The method of claim 57 wherein the hydrophobically modified hydrophilic monomer is selected from the group consisting of octadecyldimethylammoniummethyl methacrylate bromide, hexadecyldimethylammoniummethyl methacrylate bromide, hexadecyldimethylammoniumpropyl methacrylamide bromide, 2-ethylhexyl methacrylate and hexadecyl methacrylamide.

61. The method of claim 47 wherein the hydrophobically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.

62. The method of claim 47 wherein the hydrophilic monomer and the hydrophobically modified hydrophilic monomer are present in the hydrophobically modified water-soluble polymer at a mole ratio of from about 99.98:0.02 to about 90:10.

63. The method of claim 47 wherein the hydrophobically modified water-soluble polymer is selected from the group consisting of acrylamide/octadecyldimethylammoniummethyl methacrylate bromide copolymer, dimethylaminoethyl methacrylate/hexadecyldimethylammoniummethyl methacrylate bromide copolymer, dimethylaminoethyl methacrylate/vinyl pyrrolidone/hexadecyldimethylammoniummethyl methacrylate bromide terpolymer and acrylamide/2-acrylamido-2-methyl propane sulfonic acid/2-ethylhexyl methacrylate terpolymer.

64. The method of claim 63 wherein the hydrophobically modified water-soluble polymer comprises a dimethylaminoethyl methacrylate/hexadecyldimethylammoniummethyl methacrylate bromide copolymer having a mole ratio of hydrophilic monomer to hydrophobically modified hydrophilic monomer of 95:5.

65. The method of claim 46 wherein the water-soluble formation permeability reducing agent is a hydrophilically modified water-soluble polymer present in the first aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the first aqueous treating fluid.

66. The method of claim 46 wherein the hydrophilically modified water-soluble polymer is a reaction product of a hydrophilic reactive polymer and a hydrophilic compound.

67. The method of claim 66 wherein the hydrophilic reactive polymer comprises a reactive amino group.

68. The method of claim 66 wherein the hydrophilic reactive polymer is a product of a polymerization reaction in which at least one monomer is selected from the group consisting of dimethylaminoethyl methacrylate and dimethylaminopropyl methacrylamide.

69. The method of claim 66 wherein the hydrophilic reactive polymer is selected from the group consisting of polyethyleneimine, polyvinylamine, poly(vinylamine/vinyl alcohol), chitosan and polylysine.

70. The method of claim 66 wherein the hydrophilic reactive polymer comprises an alkyl acrylate polymer.

71. The method of claim 70 wherein the alkyl acrylate polymer is selected from the group consisting of polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide) and poly(acrylic acid/dimethylaminoethyl methacrylate).

72. The method of claim 66 wherein the hydrophilic reactive polymer is a reaction product of a hydrophilic monomer copolymerized with monomers containing reactive amino groups.

73. The method of claim 72 wherein the hydrophilic monomer is selected from the group consisting of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, acrylic acid, trimethylammoniumethyl methacrylate chloride, methacrylamide and hydroxyethyl acrylate.

74. The method of claim 66 wherein the hydrophilic compound is selected from the group consisting of halogen containing polyethers.

75. The method of claim 74 wherein the polyether is selected from the group consisting of polyethylene glycol, polypropylene glycol, polybutylene glycol, and mixtures thereof.

76. The method of claim 74 wherein the halogen containing polyether comprises an epichlorohydrin terminated polyethylene glycol methyl ether.

77. The method of claim 65 wherein the hydrophilically modified water-soluble polymer comprises a polymer having a molecular weight in the range of from about 100,000 to about 10,000,000.

78. The method of claim 74 wherein the weight ratio of the hydrophilic reactive polymer to the halogen containing polyether is in the range of from about 1:1 to about 10:1.

79. The method of claim 65 wherein the hydrophilically modified water-soluble polymer is selected from the group consisting of the reaction product of polydimethylaminoethyl methacrylate with epichlorohydrin terminated polyethylene glycol methyl ether, the reaction product of poly(acrylamide/dimethylaminoethyl methacrylate) with epichlorohydrin terminated polyethylene glycol methyl ether, the reaction product of polydimethylaminopropyl

methacrylamide with epichlorohydrin terminated polyethylene glycol methyl ether, and the reaction product of poly(acrylamide/dimethylaminopropyl methacrylamide) with epichlorohydrin terminated polyethylene glycol methyl ether.

80. The method of claim 65 wherein the hydrophilically modified water-soluble polymer comprises a polydimethylaminoethyl methacrylate epichlorohydrin terminated polyethylene glycol methyl ether reaction product having a mole ratio of polydimethylaminoethyl methacrylate to epichlorohydrin terminated polyethylene glycol methyl ether of 3:1.

81. The method of claim 46 wherein the water-soluble formation permeability reducing agent is a hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone present in the first aqueous treating fluid in an amount in the range of from about 0.1% to about 10% by weight of the first aqueous treating fluid

82. The method of claim 81 wherein the hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone is the reaction product of a hydrophilic polymer comprising polar heteroatoms within the polymer backbone and a hydrophobic compound.

83. The method of claim 81 wherein the polar heteroatoms present in the polymer backbone of the hydrophobically modified water-soluble polymer are selected from the group consisting of oxygen, nitrogen, sulfur and phosphorous.

84. The method of claim 81 wherein the hydrophilic polymer is selected from the group consisting of a cellulose, a chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone and a starch.

85. The method of claim 84 wherein the starch comprises a cationic starch.

86. The method of claim 81 wherein the hydrophobic compound is selected from the group consisting of an alkyl halide, a sulfonate, a sulfate, and an organic acid derivative.

87. The method of claim 86 wherein the organic acid derivative is selected from the group consisting of an octenyl succinic acid, a dodecenyl succinic acid, and an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.

88. The method of claim 81 wherein the hydrophobic compound has an alkyl chain length of from about 4 to about 30 carbons.

89. The method of claim 46 wherein the first aqueous treating fluid further comprises a gelling agent.

90. The method of claim 46 wherein the hydrophobically modified water-soluble polymer comprising polar heteroatoms within the polymer backbone has a molecular weight in the range of from about 100,000 to about 10,000,000.

91. The method of claim 46 wherein the formation permeability restoring chemical in the second aqueous treating fluid is selected from the group consisting of alkali, alkaline earth and transition metal salts of periodate, hypochlorite, perbromate, chlorite, chlorate, hydrogen



peroxide, peracetic acid, soluble peroxide salts, persulfate salts, percarboxylate acids, oxyhalo acids and mixtures thereof.

92. The method of claim 91 wherein the permeability restoring chemical is sodium hypochlorite.

93. The method of claim 91 wherein the permeability restoring chemical is present in the second aqueous treating fluid in an amount in the range of from about 1% to about 25% by weight of the second aqueous treating fluid.